

CONTROL OF MERCURY EMISSIONS BY ABSORPTION ON FLYASH – EXPERIMENTAL RESULTS OF THE CONSOL/ALLEGHENY PILOT PLANT PROGRAM

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DOE/NETL Mercury Control Technology R&D Program Review Meeting,
Pittsburgh, July 14, 2005

CONCEPT

- Absorb Hg on flyash by cooling flue gas to 200-210 °F with air heater and water spray
- Collect flyash with ESP to remove Hg
- Protect against acid corrosion and air heater fouling by introducing $\text{Mg}(\text{OH})_2$ into flue gas upstream of the air heater

POTENTIAL BENEFITS OF TECHNOLOGY

- 70-90% Hg removal
- Projected cost (\$/lb Hg) an order of magnitude lower than carbon injection by utilizing unburned carbon
- Suitable for retrofitted or new plants
- Potentially suitable for the full range of coal types
- Effective SO₃ reduction at air heater inlet
 - ▶ Visible plume mitigation
 - ▶ TRI reduction
 - ▶ SCR/SNCR benefits
 - ▶ Secondary fine particulate reduction
- Potential to improve heat rate by 2%
 - ▶ 2% reduction in NO_x, SO₂, CO, particulate and CO₂
 - ▶ ~ \$600,000/y fuel cost savings for 600 MW plant

HOST PLANT

Allegheny Energy Mitchell Station

- Courtney, PA
- 288 MW Unit 3, corner fired
- In service 1963
- Thiosorbic lime wet FGD, ESP, no SCR
- Fired with eastern bituminous coal

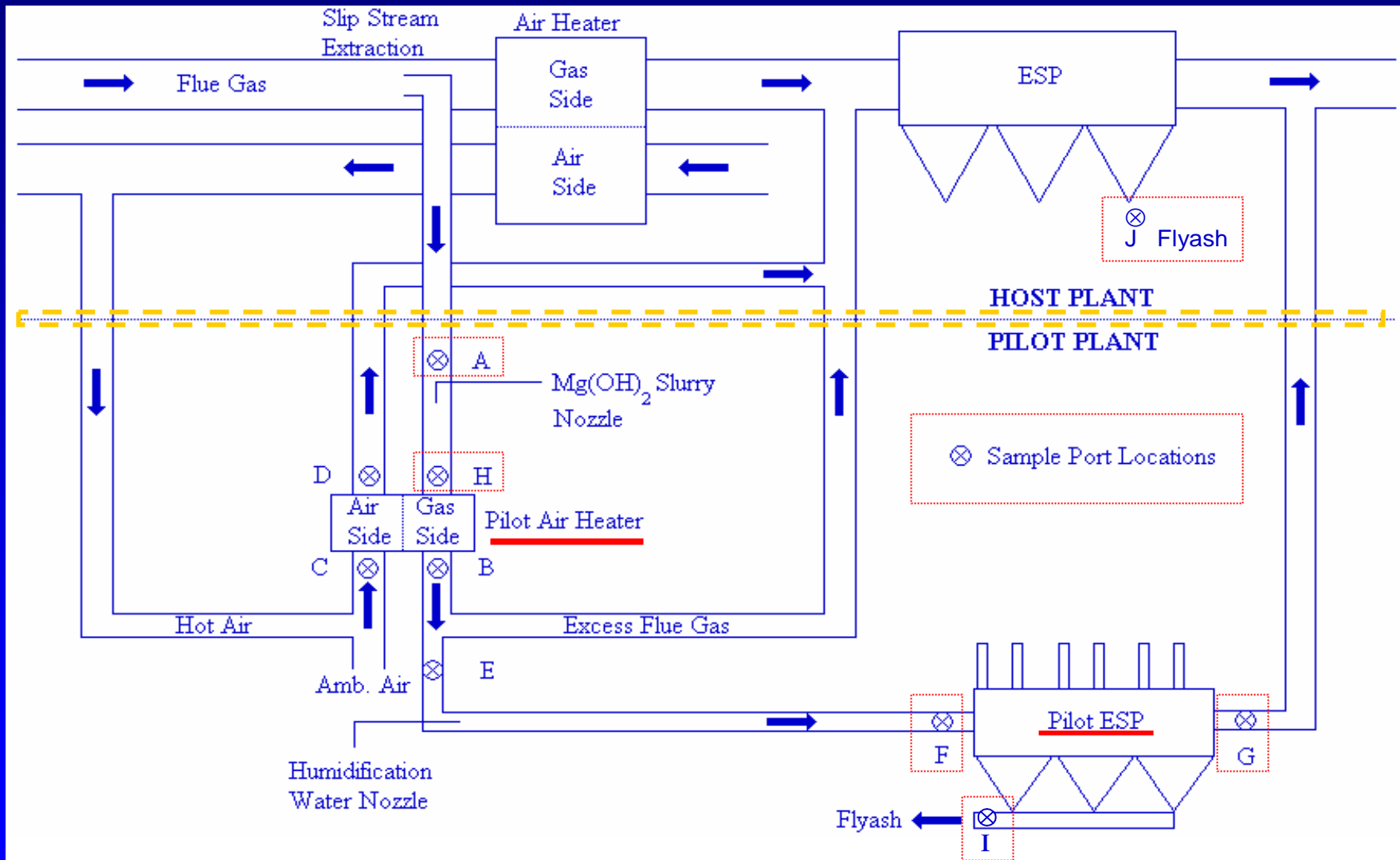
S 3.0 - 4.8% Ash 9.3 - 15%

Cl 0.05 - 0.09% Hg 0.09 - 0.13 mg/kg

*Analyses on dry basis, except Hg as determined

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PILOT PLANT PROCESS SCHEMATIC



PILOT PLANT OPERATION

Test Condition	Total Operating Hours	Continuous Operating Hours-Max.	Mg(OH)₂ Injection	ESP Flue Gas Temperature - °F
Baseline	1198	332	NO	300
Short Term	390	13	YES	230-250
Long Term	393	75	YES	200-210

EXPERIMENTAL PLAN

SO₃ CONTROL

- AH flue gas flowrate: 14,500 lb/h (1.5 MWe)
- Mg/SO₃ molar ratio: 4/1 (<3 ppmv AH inlet)
- Gas temperature at AH outlet: 225 - 230 °F
- Gas sampling: SO₃ at AH
- Coal samples: host plant
- Evaluate air heater fouling: ΔP and dissection of AH baskets
- Monitor corrosion: probe and coupons at ESP
- Sootblowing frequency: 8 hours during Baseline & Short Term, 24 to 75 hours during Long-Term

PILOT AIR HEATER

Air ↑

Flue
Gas ↓



FLUE GAS
Mg(OH)₂
INJECTION

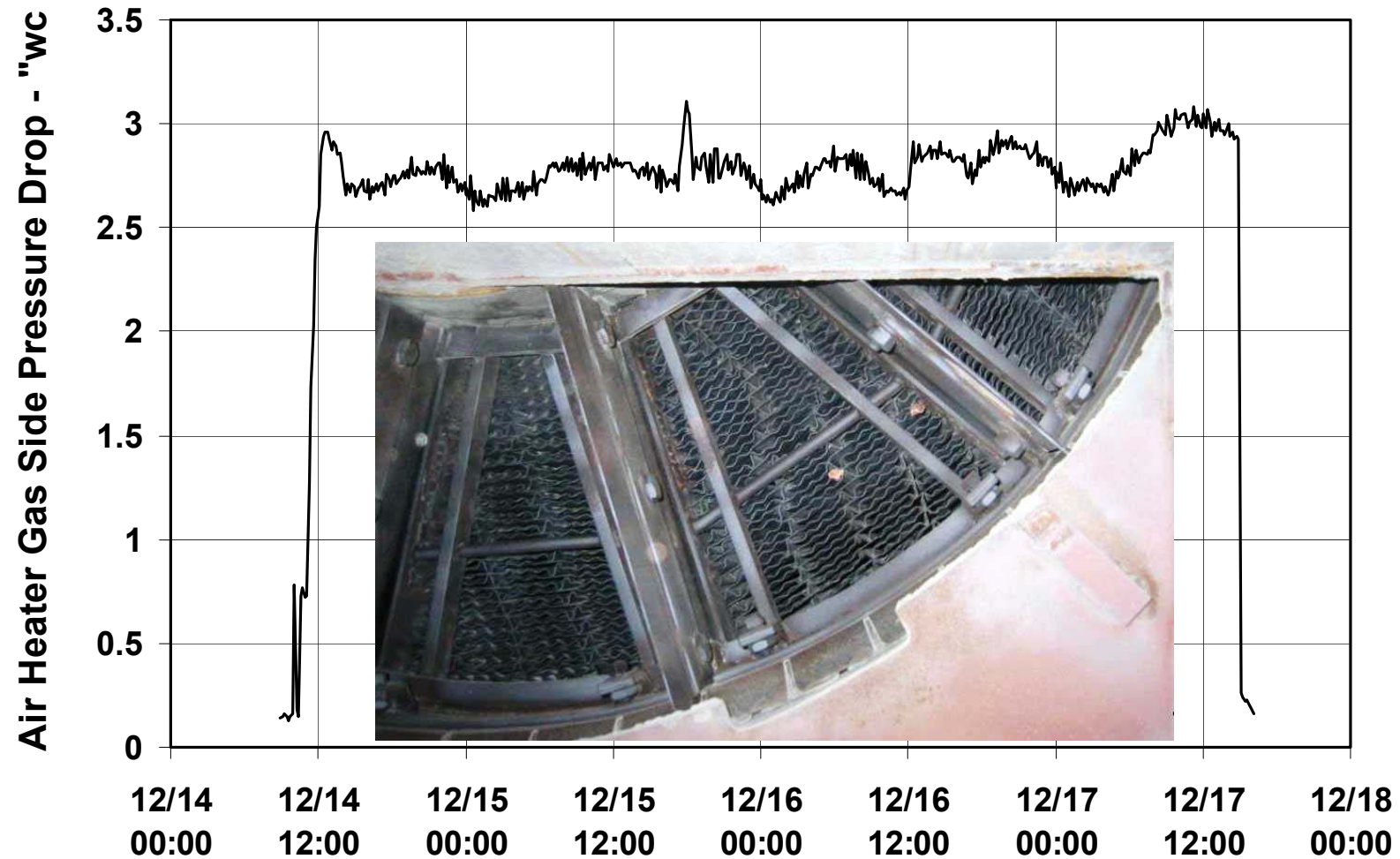


EFFECTIVENESS OF $\text{Mg}(\text{OH})_2$ INJECTION FOR SO_3 CONTROL

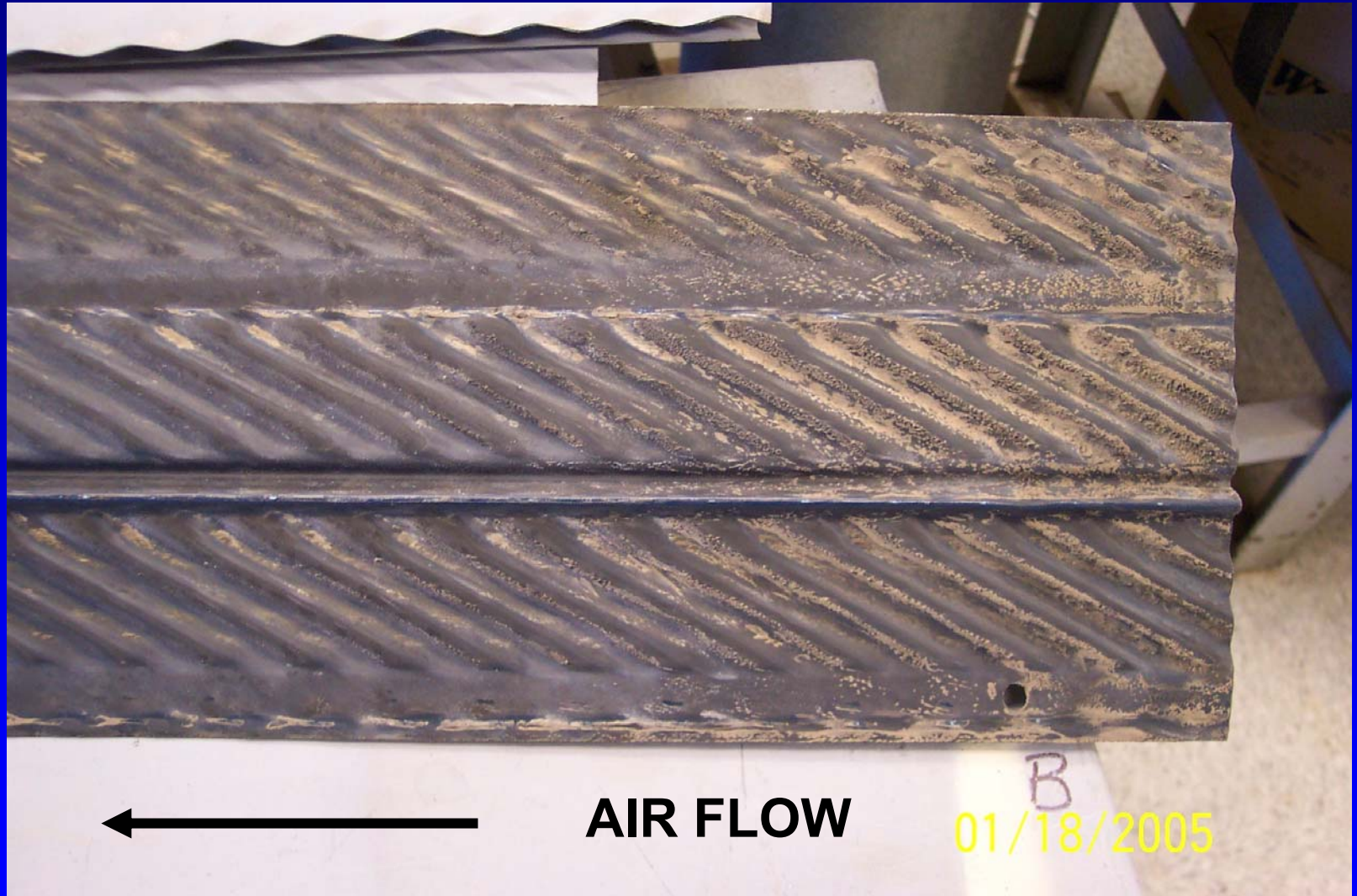
	Average SO_3 Concentration, ppmv (<i>Acid Dew Point, °F</i>)		
Mg:SO_3 Mole Ratio (Test Condition)	Before Mg Injection at Location A	After Mg Injection* > Removal % at Location H	Air Heater Gas Out at Location B
None (Baseline)	12.5 (274)	-	2.1 (237)
2/1 (Short Term)	31.4 (278)	6.8 (256) > 79%	1.2 (230)
4/1 (Short Term)	32.5 (288)	1.8 (236) > 94%	0.7 (222)
4 to 27/1 (Long Term)	14.8 (276)	2.2 (239) > 84 %	-

***3 ppmv target**

AIR HEATER PRESSURE DROP



AIR HEATER – CE ELEMENT



EXPERIMENTAL PLAN

MERCURY CONTROL

- ESP flue gas flowrate: 3,900 lb/h (100 SCA)
- Mg/SO_3 molar ratio: 4/1 (<3 ppmv AH Inlet)
- Gas temperature at ESP inlet: 200 - 210 °F
- Flue gas cooling: air heater (75 hours cont.) and water spray (4 hours cont.)
- Gas sampling: OH Hg at ESP inlet and outlet
- Flyash & coal samples: pilot ESP and host plant
- Evaluate ESP performance: PM removal >99%
- Evaluate stability: captured Hg on flyash

PILOT ESP

Outlet - G

Inlet - F



Flyash - I

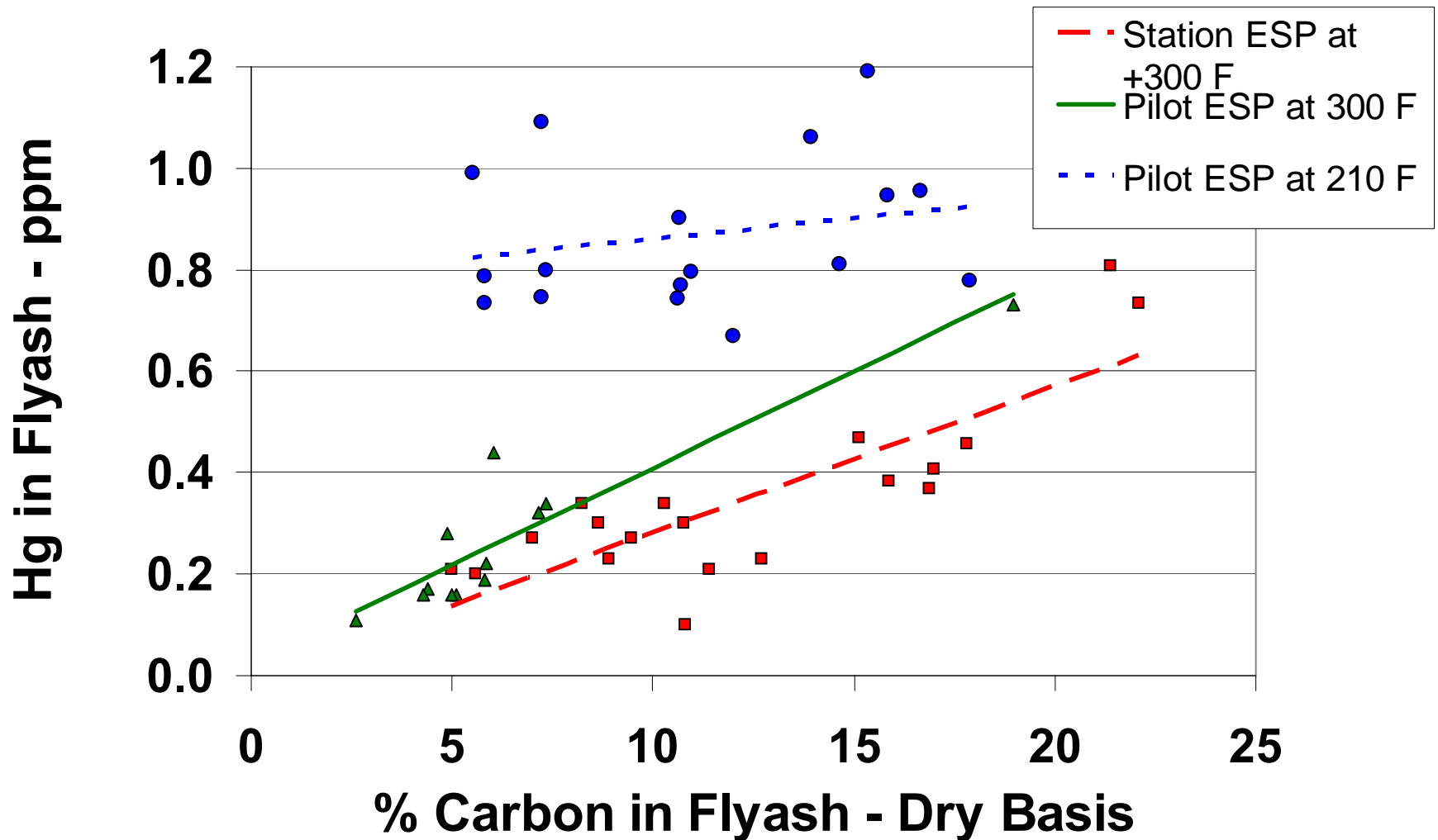
PILOT ESP INSTALLATION



MERCURY CAPTURE BY ESP

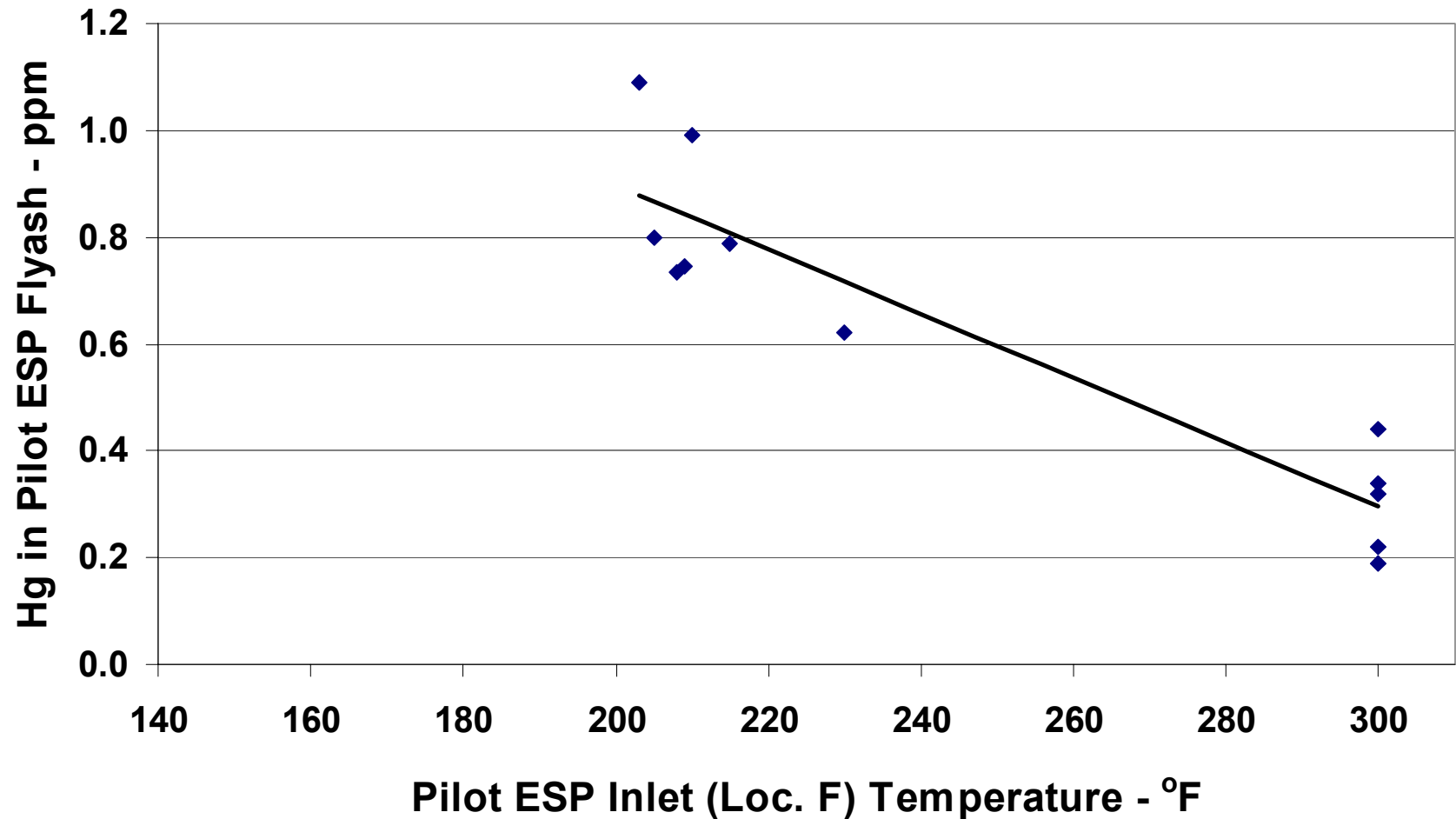
Test Condition	ESP Inlet, Location F Temp. - °F	Hg Removal By ESP, Gas Inlet to Outlet Average %	“Carbon Treat Rate” Average lbs Carbon / million scf and acf (Range of Data)	
Baseline	290	26%	41 (41) scf	26 (26) acf
Short-Term	230-250	49%	35 (46-23) scf	23 (31-15) acf
Long-Term	200-210	81%	47(71-23) scf	33 (51-15) acf

MERCURY vs CARBON IN FLYASH AT 300 °F and 210 °F



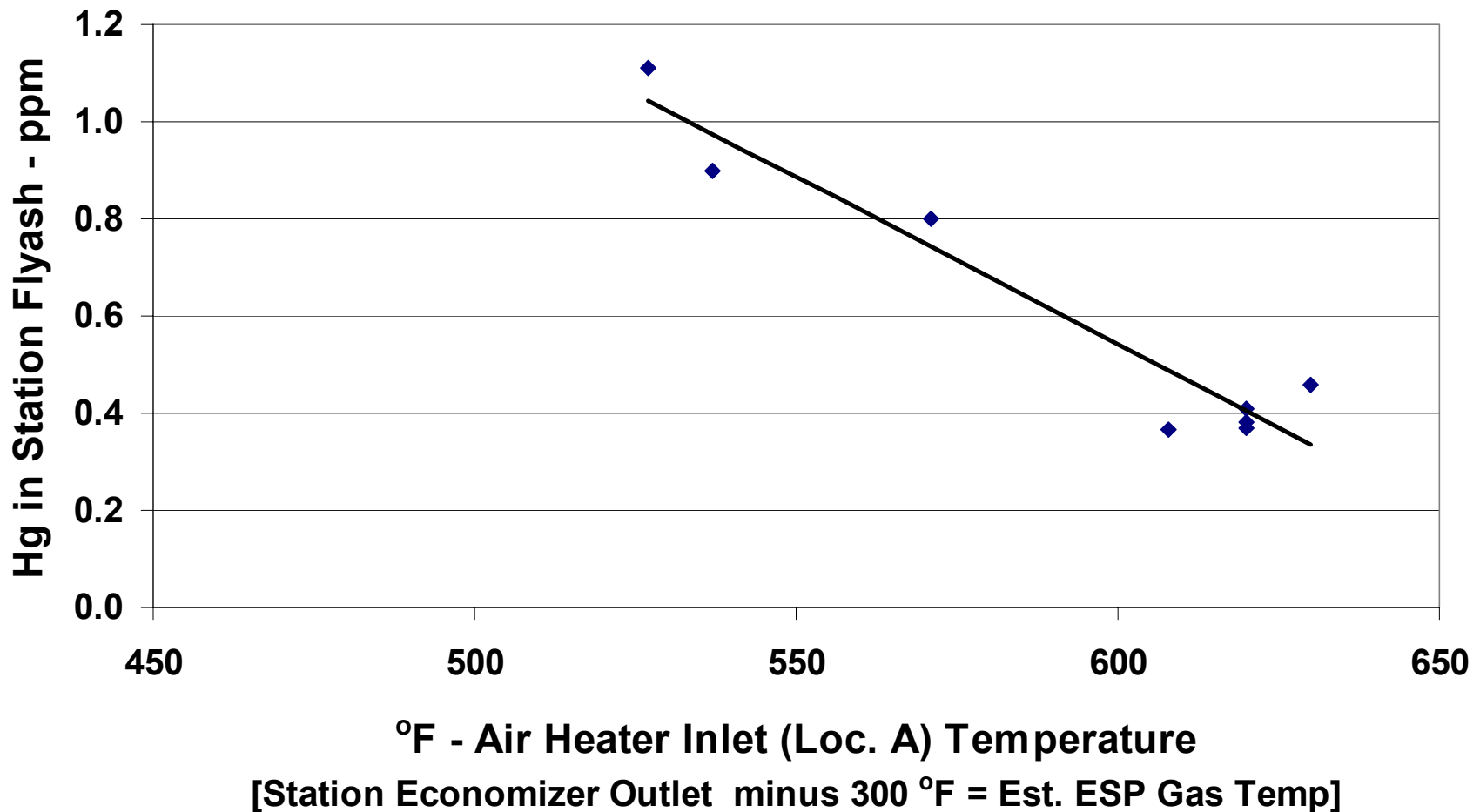
Hg on FLYASH vs TEMPERATURE

5.9-7.2% CARBON – PILOT PLANT

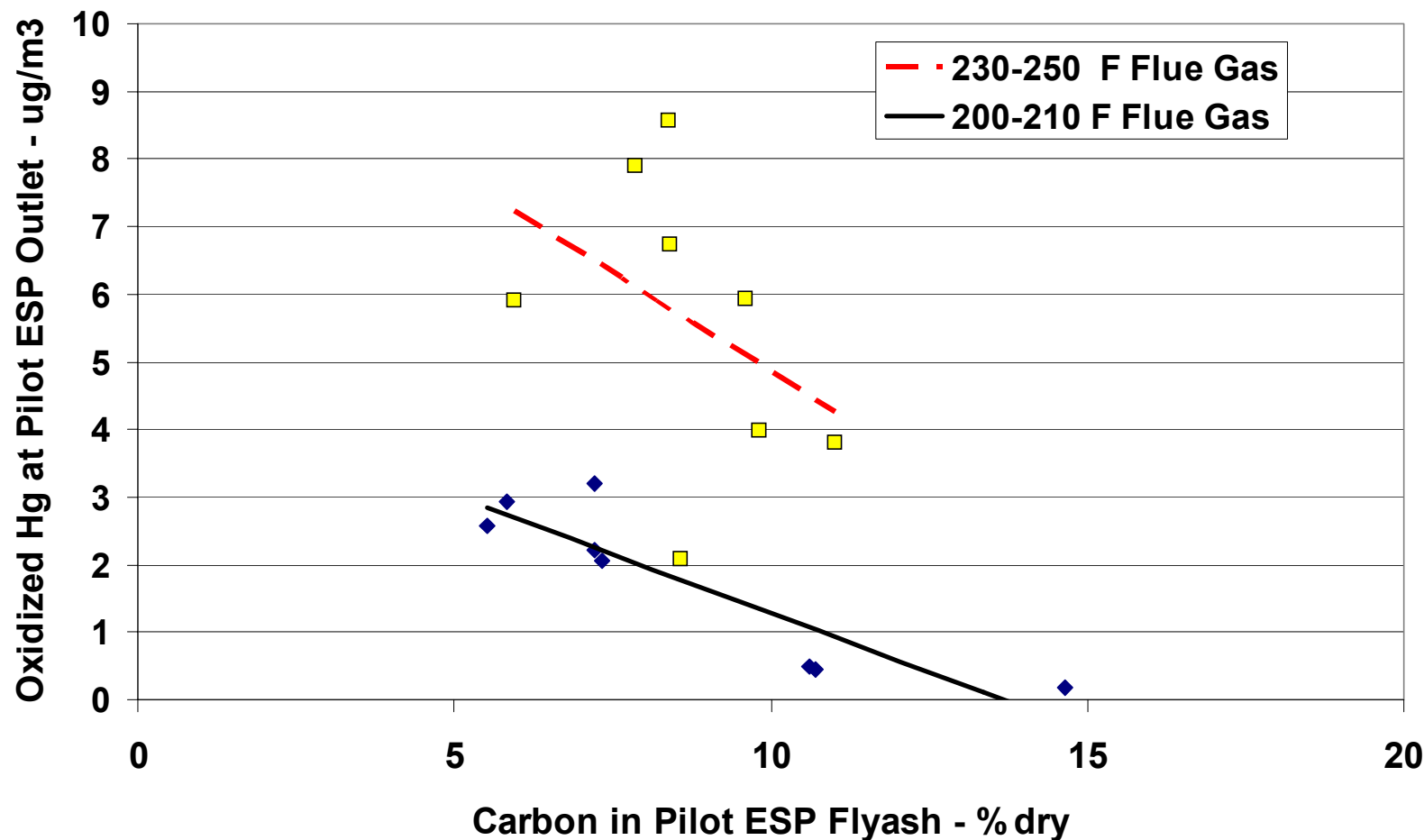


Hg on FLYASH vs TEMPERATURE

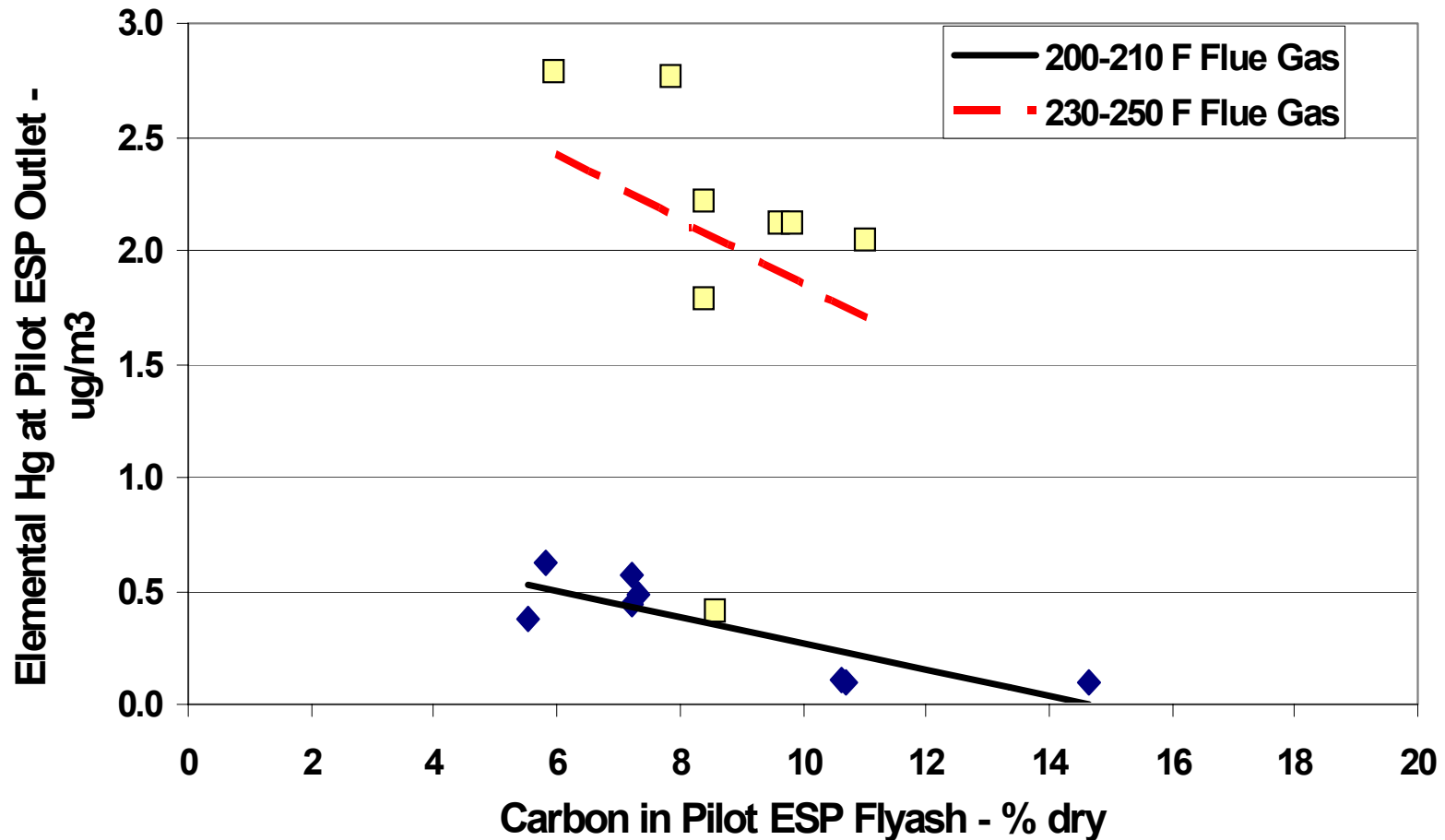
16-18% CARBON - HOST PLANT



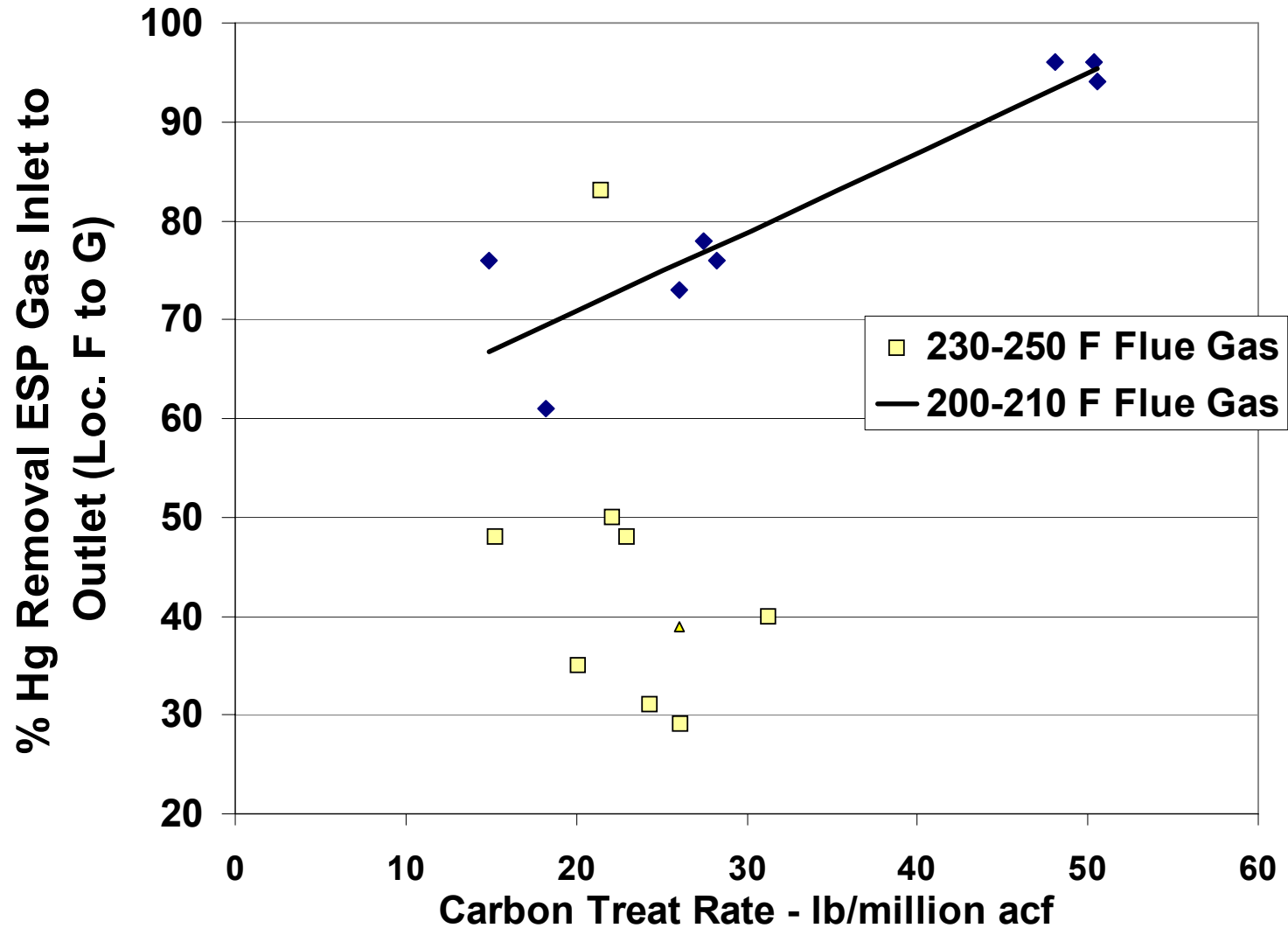
OXIDIZED Hg in FLUE GAS vs CARBON AT LOWER TEMPERATURES



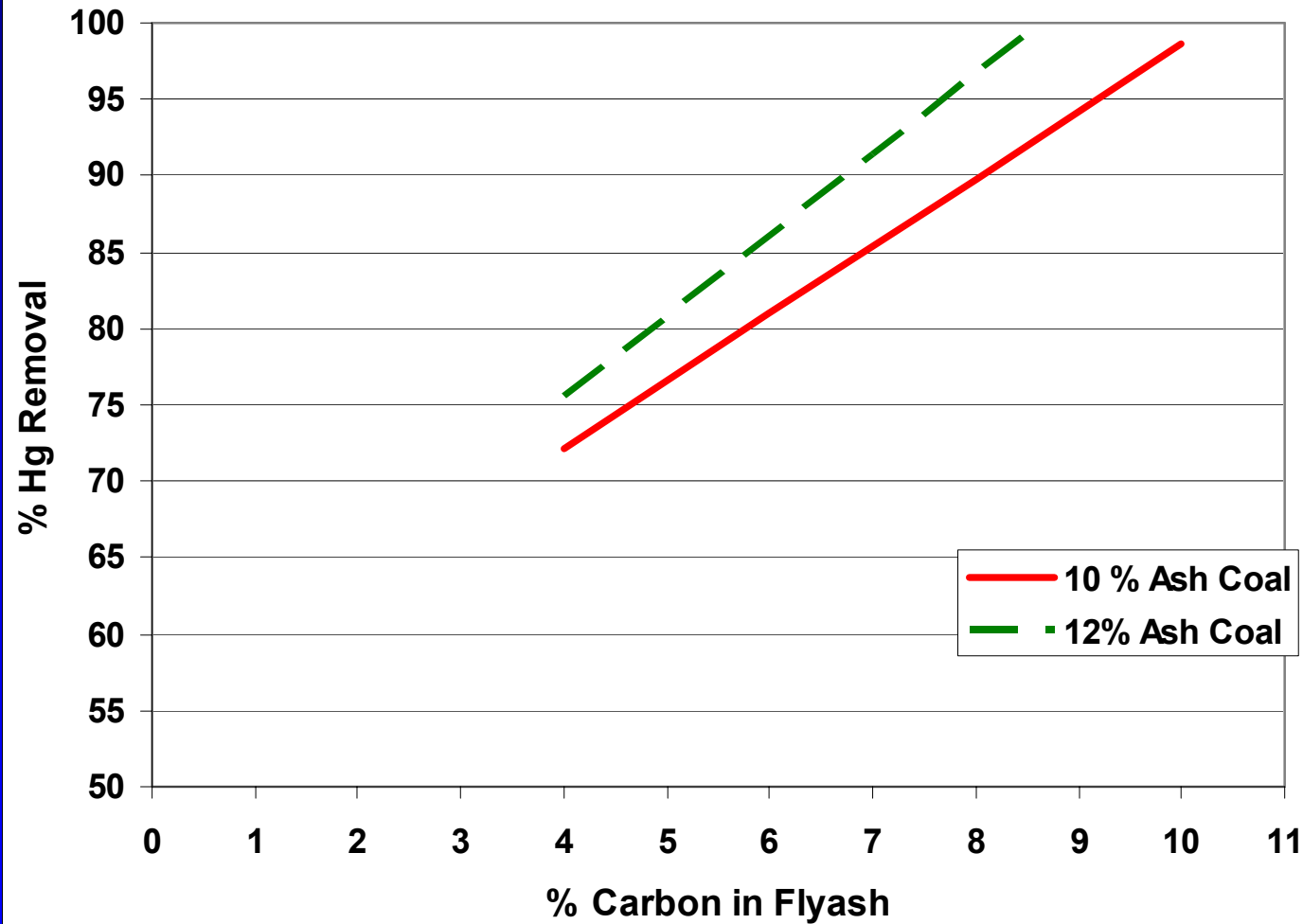
ELEMENTAL Hg in FLUE GAS vs CARBON AT LOWER TEMPERATURES



Hg REMOVAL VS CARBON RATE



Hg REMOVAL vs % UBC with 200 °F FLUE GAS



PRINCIPAL CONCLUSIONS

- Over 90% ESP mercury removal demonstrated with air heater cooling at 200-210 °F (limited WS cooling showed similar results)
- Mercury removal sensitive to temperature, carbon content of flyash and carbon content of the flue gas
- Baseline conditions give about 26% mercury removal
- At 200-210 °F, elemental and oxidized mercury effectively captured by the flyash
- $\text{Mg}(\text{OH})_2$ slurry injection is effective for removal of SO_3 and eliminates rapid fouling of the air heater
- Pilot ESP performed satisfactorily at low temperature conditions

ADDITIONAL CONCLUSIONS

- Mercury volatility and leaching tests did not show any stability problems
- No significant corrosion detected at the air heater and on corrosion coupons at the ESP
- Corrosion probe showed reduced acid condensation on corrosion probe during $\text{Mg}(\text{OH})_2$ injection

ACKNOWLEDGEMENT

- **US DOE, NETL, CA No. DE-FC26-01NT41181
(Lynn Brickett)**
- **Alstom Power, Inc.**
- **Environmental Elements Corp.**
- **Carmeuse NA, Inc.**
- **J. A. Withum, J. E. Locke and R. M. Statnick**